47. Some Miocene Cirripedes of the Genera *Hexelasma* and *Scalpellum* from New Zealand. By Thomas H. Withers, F.G.S.*

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(Plates LXXXV. & LXXXVI.† & Text-figures 139, 140.)

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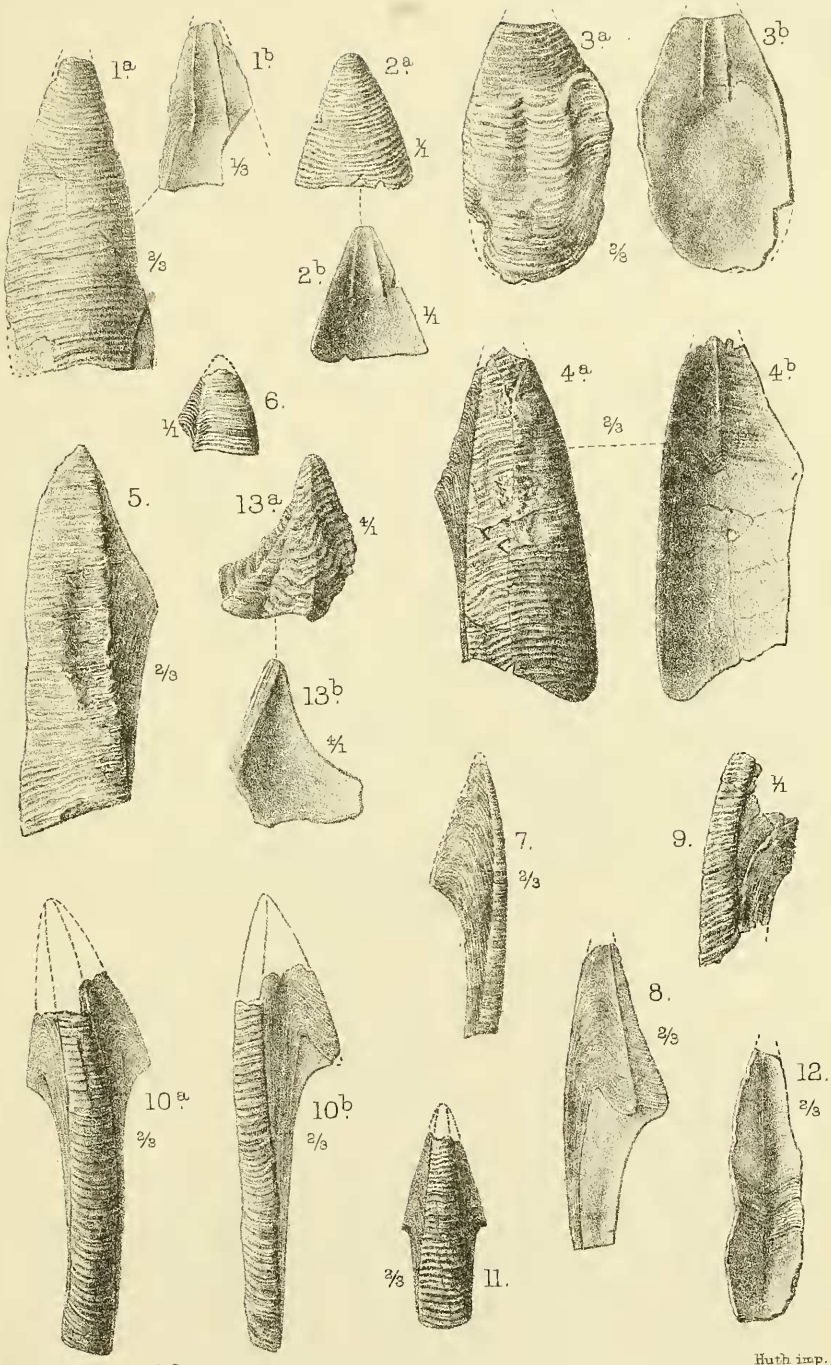
This paper contains the results of a study of the remains of the "gigantic Cirripede" (= *Hexelasma aucklandicum*) from New Zealand, as well as some notes on a smaller species of *Hexelasma*, and descriptions of two new species of *Scalpellum*. One of the latter is founded on some valves in the Geological Department of the British Museum, and the remaining species of *Scalpellum* and the small *Hexelasma* were found associated in the matrix with the remains of *Hexelasma aucklandicum*.

Remains of a gigantic Cirripede have long been known to occur in the Waitemata Beds (Miocene) of Motutapu Island, Auckland Harbour, New Zealand. These remains have been considered by Sir James Hector (1887) and Prof. W. Blaxland Benham (1903) as belonging to a pedunculate Cirripede; but while the former referred them to the genus *Scalpellum*, the latter thought that they approached more closely to the genus *Pollicipes*.

On learning of my wish to see some of these remains, Prof. James Park was good enough to write to Dr. J. Allan Thomson, Palæontologist to the Geological Survey, Dominion Museum, Wellington, who most kindly sent me the actual specimens collected by Prof. Park in 1887. Prof. Park wrote also to Prof. Benham, who sent me plaster-casts of the specimens figured by him in 1903; these casts are now in the Geological Department of the British Museum. My thanks are therefore due to Professors Benham and Park and Dr. J. Allan Thomson, and I have also to acknowledge the kindness of Dr. A. Smith Woodward in allowing me to describe the new species of *Scalpellum* in the Geological Department of the British Museum.

* Communicated by Dr. W. T. Calman, F.Z.S.

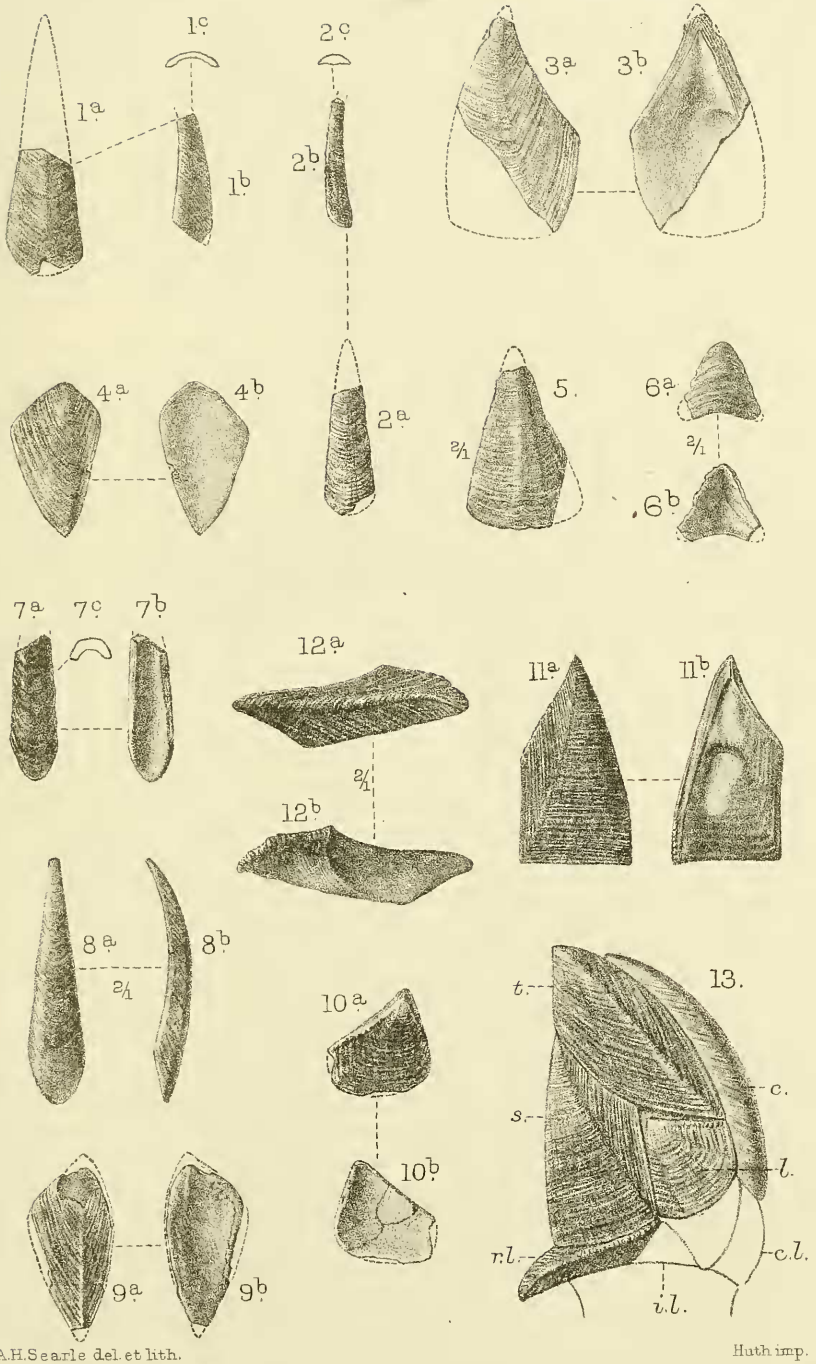
† For explanation of the Plates, see p. 854.



A.H.Searle del. et lith.

Huth imp.

HEXELASMA AUCKLANDICUM, *Hector sp.*



A.H.Searle del.et lith. Huth imp.

Figs. 1-6. SCALPELLUM SUBPLANUM. *sp.n.*

Figs. 7-13. S.(ARCOSCALPELLUM) UNGULATUM. *sp.n.*

Balanidæ.

Genus Hexelasma.

1913. *Hexelasma* P. P. C. Hoek, Siboga-Expeditie, Cirripedia Sessilia, p. 244.

"Compartments six; carina, carino-lateral, and lateral compartments with alæ, but without radii, the rostrum having neither radii nor alæ. Parietes not porose and without longitudinal ribs on their inner surfaces; basis membranous. Opercular valves sub-triangular." . . . . P. P. C. Hoek.

Hexelasma aucklandicum Hector sp. (Pl. LXXXV.)

1888. *Scalpellum aucklandicum* Hector, Trans. N.Z. Institute, vol. xx. (1887) p. 440.

1903. *Pollicipes ? aucklandicus* Hector sp.: W. B. Benham, "On some Remains of a Gigantic Fossil Cirripede from the Tertiary Rocks of New Zealand," Geol. Mag. London, dec. 4, vol. x. p. 111, pls. 9, 10 (*non* figs. 8, 9).

1905. *Pollicipes aucklandicus* Benham: E. Clarke, "The Fossils of the Waitemata and Papakura Series," Trans. N.Z. Institute, vol. xxxvii. (1904) p. 419.

1910. *Pollicipes ? aucklandicus* Hector sp.: J. Park, "Geology of New Zealand," p. 115 (pl. 7), pp. 113, 134.

Diagnosis. Compartments attaining a length of at least 187 mm., carinal, carino-lateral, and lateral compartments with simple alæ (*i. e.*, there is no distinct upturned extension at the margin). Sheath feebly developed, almost absent, and with no sutural edge to abut against the longitudinal ridge formed on the inner surface. Opercular valves unknown (except for probably a single tergum).

Material. 7 rostral compartments, 9 carinal, 13 lateral (8 right and 5 left), 5 carino-lateral (3 right and 2 left), together with a small tergum (Pl. LXXXV. figs. 13 *a*, *b*), which may or may not belong to the species; all these are more or less imperfect. The specimens are in the collection of the Geol. Surv. New Zealand, and are marked with the locality-number 695. They are presumably the syntypes of Hector. In addition to these specimens I have examined plaster-casts of the specimens figured by Prof. Benham.

Holotype. From among the syntypes of Hector I select as holotype the rostrum here figured on Pl. LXXXV. fig. 1.

Horizon and Locality. Miocene, Oamaruian, Base of Waitemata Beds: Motutapu Island, Auckland Harbour, New Zealand.

General Remarks. Sir James Hector (1887) first called attention to this fossil, and at a meeting of the Wellington Philosophical Institute he remarked on some remains of it there exhibited:—

"Specimens of a large fossil stalked Cirripede, recently

collected by Mr. Park, at Motatapu Island, Auckland. A careful restoration will have to be made before definitely determining this fossil, but it will probably be found to belong to the genus *Scalpellum* and is distinguished provisionally under the name *S. aucklandicum*. In size, this fossil Cirripede greatly exceeds any previously known, in *S. magnum* the capitulum being only $1\frac{1}{2}$ inches in length, while in the Auckland specimen it is at least 8 inches. These fossils occur in a breccia, marking the old shore line of the upper part of the Waitemata Series, similar to the Cape Rodney beds. The associated fossils are Corals, Brachiopods, and Echinoderms. Among the latter are two specimens having plates of a Cidaris of enormous size."

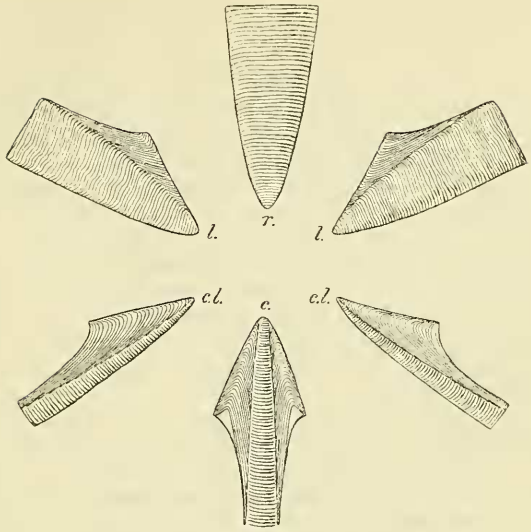
Attention was again called to this fossil in 1903, when Prof. Benham described and figured certain valves. He considered that they showed closer resemblance to the capitular valves of certain species of *Pollicipes*, and doubtfully referred them to that genus.

After an examination of the present material I am convinced that the valves belong to a sessile Cirripede allied to *Balanus*. There are six compartments—a rostrum, carina, right and left lateral, and right and left carino-lateral. Prof. Benham figured only four valves, namely, "a carina, left scutum, ?rostrum, and ?upper latus." The carina figured by him is the same as that now considered as a carina, and the scutum and ?upper latus correspond to the right and left lateral compartments respectively; but the valve figured (Benham, 1903, pl. 10, figs. 8, 9) as a "?rostrum" is really a carina of *Scalpellum subplanum*, sp. n. (see p. 848). The valves considered here as rostral and right and left carino-lateral compartments were not figured by Benham, and it has now been possible to give figures of the inner surface of each different compartment.

Description of Valves. Valves with solid walls of variable thickness, apparently not more than 2·25 mm.; externally marked with prominent, more or less regular, transverse growth-ridges, rather more strongly marked on the carina; sometimes ridged longitudinally, and in one or two cases the valves are distorted by linear depressions; but all the valves are more or less irregular in shape, and this is obviously caused by the surface of attachment; inner surface not longitudinally ribbed near the base as in *Balanus*, for the smooth inner surface slopes gradually to meet the outer surface and forms a definite, more or less smooth edge.

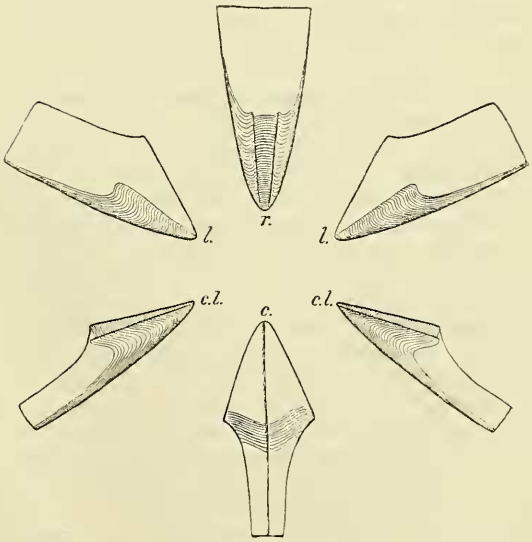
Rostral compartment (Pl. LXXXV. figs. 1–3) without radii, almost symmetrical, moderately convex transversely and slightly convex longitudinally, bluntly angular at the apex, and either rounded or slightly concave at the basal margin; triangular in shape when young, but in the older and consequently longer valves the lateral margins for the greater part are almost parallel to each other. On the inner surface two more or less prominent ridges extend from the apex, and die out at a point halfway from the apex in the young valve (fig. 2) and at a

Text-fig. 139.



Outer views.

Text-fig. 140.



Inner views.

Hexelasma aucklandicum Hector sp.
Restored compartments.
r., rostrum; *l.*, lateral; *c.l.*, carino-lateral; *c.*, carina.

point about one-third the length of the valve from the broken apical portions in the larger valves (figs. 1, 3). Obviously these ridges serve for the reception of the angle of the alæ on the adjacent lateral valves, and the space between the ridges is marked, in the older specimens, with transverse lines. The portion of the valve enclosed by the ridges is half as wide as the adjacent parts of the valve in the specimen figured (fig. 3 *b*), but in the valves figured (figs. 1 *b*, 2 *b*) it is wider. At the base of the two ridges extending from the apex, and only in the largest valve (fig. 1 *b*), a slight transverse ridge is formed by the thickening of that part of the valve enclosed by the ridges. From a point about one-third from the base of the valve, a small extent of the inner surface, parallel to the outer margins, is marked with lines which extend upward, and bend abruptly inwards towards the base of the ridge on either side; these lines are made by the alæ of the lateral compartments which are overlapped by this part of the valve.

Lateral compartment (figs. 4–6) with an ala on the rostral side, moderately convex transversely, and longitudinally almost flat, irregularly convex, and in one case bent in an elongately S-shaped curve; the whole valve is usually strongly bent towards the rostrum, but one valve is strongly bent away from the rostrum. Parietal portion very much wider than in the carino-lateral compartment, as much as three times as wide as the widest part of the ala in one valve, and in others from two to under one and a half times as wide. The two margins of the ala form an obtuse angle, the upper margin is practically straight and the lower somewhat concave, but their shape is influenced by the degree of curvature of the valve; the growth-lines on the ala are closely set and extend obliquely upwards from the base, and on reaching almost to the upper margin curve downwards to the angle of the ala; on the lower margin, near the angle, a small smooth portion is left just below where the growth-lines bend downwards. On the inner surface, almost at the middle of the parietal portion, a more or less prominent ridge extends from the apex and dies out at a point opposite the angle of the ala; near the parietal margin the inner surface is marked with lines which extend upwards, and on reaching a point just above the base of the longitudinal ridge bend sharply inwards and downwards to meet its lower extremity; these lines are obviously made by the ala of the carino-lateral compartment, the angle of which abuts against the longitudinal ridge. Between the longitudinal ridge and the upper margin of the ala the inner surface is marked with indistinct and irregular transverse lines.

Carino-lateral compartment (figs. 7–9) obtusely triangular in general outline, with an ala on the rostral side. The whole valve bent, especially in its apical half, towards the rostrum, is almost flat transversely, and the parietal portion is much narrower than that of the lateral compartment; the two margins of the ala

form an obtuse angle, the upper margin of which is straight and obliquely inclined towards the apex, and the lower margin, which is concave, emerges from just above the base of the valve, and curves gently upwards and then sweeps sharply outwards to meet the upper margin. Parietal portion of valve extremely narrow, the widest part being about one-fourth the width of the widest part of the ala. On the ala the growth-lines are closely set, and follow a similar course to those on the lateral compartment. Beneath the upper half of the ala, a portion of the valve on the inner surface is somewhat thickened for about one-third the width of the valve; its inner margin is steep-sided, and forms a ridge, against which abuts the angle of the alæ of the carinal department; the thickened portion of the valve widens gradually from the apex, dies out at a point opposite the angle of the ala, and is marked with fine, regular, closely-set, transverse lines. Near and parallel to the lower half of the parietal margin, and for about one-third the width of the valve, the inner surface is marked with lines which extend upwards, and, on reaching about half the length of the valve, are angularly bent downwards and inwards, and the lowest of them meet the base of the steep-sided ridge near the upper margin of the ala; these lines correspond to, and are obviously made by, the alæ of the carina, which are overlapped by the portion of the valve thus marked.

Carinal compartment (figs. 10–12) gently curved longitudinally, with an ala on each side, and these are bent at a sharp angle from the parietal portion. Parietal portion narrow, transversely convex, especially near the apex, much narrower than the parietal portion of the lateral compartment, but wider than that of the carino-lateral compartment; alæ about one and a half times as wide as the widest part of the parietal portion, and in one young valve about the same width as the parietal portion. The alæ emerge from near the base of the valve, widen gradually upward until about two-thirds the distance from the base, and here they bend further outwards and then sharply upwards to the apex; the two margins, therefore, roughly form an obtuse angle, the basal margin of which is somewhat concave, and the upper margin, which is the shorter, is straight. The growth-lines on the alæ extend obliquely upwards from the base and, on reaching a point more than halfway across the alæ, bend sharply and angularly downwards to the margin; a smooth triangular portion of the valve is left beneath the angularly bent growth-lines. The inner surface is quite smooth except for some transverse lines, which mark the surface above the angle of the alæ and which are more prominent at this point.

Measurements. The largest valve in the present series (a carina, fig. 10) would measure, if complete, circa 90 mm., and the smallest valve (a lateral compartment, fig. 6) circa 12 mm. One of the compartments (a lateral) figured by Prof. Benham as a scutum measures 187 mm.

Structure and Affinities. It is evident from the structure of the inner surface of the compartments of this Cirripede, and from the modification of the side wall of the compartments to form alæ, that the elements combined to form a shell something like the compartments in the genus *Balanus*. This is proved by the fact that the lines on the inner lateral portions of the rostrum correspond to, and are obviously made by, the growth-lines of the ala of each lateral compartment, which was overlapped by the lateral portions of the rostrum; similarly shaped lines on the lateral compartment correspond to those on the ala of each carino-lateral compartment which was overlapped by the lateral compartment; the more angularly bent lines on the carino-lateral compartments correspond to those on the alæ of the carinal compartment which were overlapped by the carino-lateral compartment. In addition, more or less prominent longitudinal ridges are developed in the upper portions of the rostral, lateral, and carino-lateral compartments against which the angle of the ala of the adjacent valves abutted. The transverse lines on the portions of the compartments not covered by the alæ are similar to those in *Balanus*, in which they are caused by the successive exuviation of the opercular membrane. To a similar cause may be attributed those in the present Cirripede.

That this form is a sessile Cirripede is, I think, beyond doubt, and the irregularity in shape of the several compartments, as well as the fact that some are externally and irregularly ridged longitudinally and others distorted with linear depressions, is further evidence in support of this conclusion, for these features could be caused only by the irregularity in the surface of attachment. In accordance with the above interpretation, six compartments would complete the wall of the shell, as in *Balanus*; and it is important to note that every fragment in the present collection can be allocated to one of the six valves figured. (Pl. LXXXV. & Text-figs. 139, 140.)

The shell of this form could not have been very strong, for, in comparison with the great length attained by the compartments, the walls are relatively quite thin. The compartments could have been only weakly attached, and are in consequence always found quite apart from one another. Moreover, the absence of radii, together with the absence of sutural edges to the alæ and the comparatively feeble ridges or shoulders developed on the inner surface, and against which only the angles of the alæ could have abutted, show quite clearly the great structural frailty of the shell. It could hardly have been a littoral barnacle.

Although this form agrees with the typical species of the genus *Balanus* in the number of compartments forming the walls of the shell, it differs markedly in the structure of these compartments. These differences are (1) the absence of radii, (2) the simpler structure of the alæ, (3) the absence of longitudinal ribs on the inner surface, (4) the feebly developed sheath, as well as the

absence of a sutural edge to abut against the longitudinal ridge on the inner surface. All these are primitive characters, and show that in this Cirripede we have a Balanid more primitive than *Balanus*.

In my preliminary consideration of this form I regarded it as being related, mainly in the absence of radii, to the recent species *Balanus hirsutus* and *B. corolliformis*, which were included by Dr. Hoek * in a new section (G) of *Balanus*, and *B. hoekianus* and *B. callistoderma*, which were referred by Dr. Pilsbry † to the same section, and I intended to found a new genus to include these species. On seeing a proof of Dr. Hoek's work (1913, 'Siboga-Expeditie, Cirripedia-Sessilia,' pp. 244–246), however, I found that he had included these recent species, together with two new species (*H. velutinum* and *H. arafurae*), in a new genus *Hexelasma*.

Dr. Hoek kindly sent me drawings of the type-species *H. velutinum*, and from these it could be seen that while *Hexelasma* differs from *Balanus* in the absence of radii and the absence of longitudinal ribs on the inner surface, it agrees in having a well-developed sheath, and in the carino-lateral compartments having an upturned extension of the alæ as well as a well-developed sutural edge.

Since "*Pollicipes* (?) *aucklandicus*" agrees with *Hexelasma* in the absence of radii and of longitudinal ribs on the inner surface, it seems advisable to refer it to that genus; but in some respects it appears to be somewhat more primitive than the typical species of *Hexelasma*, especially in the feeble development of the sheath, in the absence of a distinct upward extension to the alæ of the carino-lateral compartments, and of a sutural edge to the alæ of the carino-lateral compartments.

The species included in *Hexelasma* are all deep-sea forms, and occur at depths varying from about 100 to 900 m. In length the shell of the largest species, *H. corolliforme* Hoek, measures nearly 45 mm., and since the largest-known compartment of the fossil *H. aucklandicum* measures about 190 mm., the great difference in size is apparent.

Except for *Balanus psittacus* Molina sp., which has been known to attain a length of 9 inches (circa 225 mm.), *Hexelasma aucklandicum* is the largest-known Cirripede. *Balanus evermanni* Pilsbry, another large barnacle, is recorded as measuring 150 mm.

Hexelasma sp.

A large number of the disconnected compartments of a small Balanid are to be seen scattered about in the matrix containing

* 1883. P. P. C. Hoek, 'Challenger' Report, Zoology, vol. viii. pp. 155–160.

† 1911. H. Pilsbry, "Barnacles of Japan and Bering Sea," Bull. Bureau Fisheries, Washington, vol. xxix. 1909, pp. 76–80.

the compartments of *Hexelasma aucklandicum* and the valves of *Scalpellum subplanum*, sp. n. Those that I have been able to extract and clean appear to be somewhat worn, and the largest of them does not measure more than 5 or 6 mm. in length; their outer walls are thrown into comparatively wide longitudinal folds. Owing to their worn appearance the finer characters are not well shown, but since they do not appear to possess radii they must be referred to the genus *Hexelasma*. They differ, however, from the typical species of *Hexelasma*, as well as from the fossil *H. aucklandicum*, in having a well-developed sheath, and in the presence of strong ribs on their inner surface. *Balanus hoekianus* Pilsbry (1911, "Barnacles of Japan and Bering Sea." Bull. Bureau Fisheries, Washington, vol. xxix. 1909, p. 77, text-fig. 8), which has now been referred by Dr. Hoek to his genus *Hexelasma*, agrees with the present compartments in the presence of ribs on the inner surface, but it would be rash to say that they are related specifically. In view of the unsatisfactory preservation of these compartments, and in the absence of the opercular valves, I do not think it advisable to institute a new species.

Horizon and Locality. Miocene, Oamaruian, Base of Waitemata Beds; Motutapu Island, Auckland Harbour, New Zealand.

Collection. Geol. Surv. New Zealand.

Pollicipedidæ.

Genus Scalpellum.

1817. *Scalpellum* Leach, Journ. de Physique, &c., lxxxv. p. 68.

Scalpellum subplanum, sp. n. (Pl. LXXXVI. figs. 1–6.)

1903. *Pollicipes* (?) *aucklandicus* Hector sp.: W. B. Benham, Geol. Mag. dec. 4, vol. x. p. 114, pl. 10, figs. 8–9.

Diagnosis. Carina not separated into tectum, parietes, or intraparietes, flatly arched transversely, basal margin bluntly angular; tergum with the upper carinal margin unusually short, and making with the occludent margin an obtuse angle; rostrum with a wide, flat median keel extending from the apex to the basal margin.

Material. 2 carinæ, 2 scuta, 4 terga, 1 rostrum, and 1 subcarina; most of these are incomplete, and they were all extracted from the matrix containing the valves of *Hexelasma aucklandicum*.

Holotype. The carina figured on Pl. LXXXVI. fig. 2.

Collection. Geol. Surv. New Zealand.

Horizon and Locality. Miocene, Oamaruian, Base of Waitemata Beds: Motutapu Island, Auckland Harbour, New Zealand.

Carina not separated into tectum, parietes, and intraparietes, bowed moderately either inwards or outwards, widening gradually

from the apex to the basal margin, which is more or less bluntly angular; flatly arched transversely and indistinctly carinate. The apical portion of the smaller specimen is thickened to quite a third of its extent, the inner portion forming almost a flat surface extending from each side of the carina.

Length (fig. 1, basal half of valve) 16·5 mm.; breadth 10 mm.

Length (fig. 2, basal $\frac{2}{3}$ of valve) 16·6 mm.; breadth 6·4 mm.

Scutum trapezoidal, nearly twice as long as wide, divided almost equally by an indistinct, flat, wide ridge extending from the apex to the basi-lateral angle. Occludent margin convex; basal margin almost straight. Tergal margin slightly concave, of about the same length as the convex lateral margin, with which it forms an obtuse angle. Along the tergal margin the valve is rounded towards the inner surface. The inner occludent edge is broad, flat, of about the same width throughout, marked with growth-lines, and overhangs the depression for the adductor scutorum opposite the tergo-lateral angle; the inwardly rounded tergal edge is marked with growth-lines, but the extent thus marked narrows rapidly towards the tergo-lateral angle.

Length (fig. 3, incomplete valve) 28·7 mm.; breadth 17 mm.

Tergum subrhomboidal, with an obscure ridge extending in a straight line from the apex to the basal angle, and dividing the valve unequally, the occludent portion being in its widest part almost twice as wide as that of the carinal portion; lower carinal margin weakly convex, somewhat longer than the scutal margin, and forming with it an acute angle; upper carinal margin slightly convex, unusually short, and forming an obtuse angle with the slightly convex occludent margin, which is almost twice its length. The occludent margin forms a somewhat raised border, and this is followed by a wide, shallow depression bounded by an obscure ridge extending from the apex to a point on the scutal margin, which is slightly produced about one-third the distance from the basal angle; from this ridge the valve slopes upwards towards the apico-basal ridge, and slopes rapidly down to the carinal margin. On the inner surface a narrow portion of the valve along the occludent and upper carinal margins is marked with growth-lines, and the extent thus marked is wider beneath the apex.

Length (fig. 4) 20 mm.; breadth 12·4 mm.

Rostrum subtrianglar, strongly convex transversely, bowed inwards, basal margin convex; lateral margins slightly concave; a flat submedian keel extends from the apex to the basal margin, and this on the right side is followed by a further longitudinal ridge near the lateral margin, but on the wider left side this ridge, if present, is extremely obscure.

Length (fig. 5) 10·5 mm.; breadth (when complete) circa 8 mm.

Subcarina triangular, moderately convex transversely, bowed inwards; apex rounded; basal margin concave; lateral margins slightly concave. On the inner surface a slight, but well-defined

ridge extends from the apex to about the middle of the valve, and is there met by two further ridges extending from each basal angle; the valve is thus divided into three almost equal portions, the basal one being smooth and doubtless covered at one time by the corium, the two upper portions being marked with growth-lines and most probably overlapping the adjoining carino-lateral valve on either side.

Length (fig. 6) 5 mm.; breadth 5·2 mm.

Comparison with other Species. This species is referred to the genus *Scalpellum* (*sensu lato*), a course that is advisable until we can find the remaining valves of the capitulum, which may enable us to refer the species to one of the subgenera into which *Scalpellum* has been divided. Judging from the known valves (carina, scutum, tergum, rostrum, and subcarina), this species is related to *S. zancleanum* Seguenza* from the Pliocene of Messina, Sicily. The carina of *S. zancleanum* differs in having a strong median keel, from which the sides of the valve slope steeply, and in the less angular growth-lines; the scuta differs in the rounded basal margin and in the usually less acute tergo-lateral angle; the terga differ in being much narrower in proportion to width, in the much more acute apical portion, and in the carinal margin not being divided into an upper and a lower portion; the rostrum differs in the absence of a wide, flat, median keel.

Subgenus Arcoscalpellum.

1907 (Oct.). *Arcoscalpellum* P. P. C. Hoek, Siboga-Expeditie, Cirripedia Pedunculata, p. 59.
1907 (Nov.). *Holoscalpellum* H. A. Pilsbry, Bull. No. 60, U.S. Nat. Mus. p. 25.
1908. *Arcoscalpellum* Hoek; H. A. Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, p. 109.
1912. *Arcoscalpellum* Hoek; T. H. Withers, Proc. Zool. Soc. London, p. 538.

Scalpellum (Arcoscalpellum) ungulatum, sp. n. (Pl. LXXXVI. figs. 7–13.)

Diagnosis. Carina with its tectum almost flat, parietes more than half the width of the tectum, intraparietes narrow and bent abruptly inwards, basal margin rounded; upper latera sub-triangular, with rounded basal margin and wide lateral portions obliquely inclined towards the umbo; rostral latus with sub-parallel scutal and basal margins, and about one-third of its apical end, which is much thickened, projecting freely beyond the scuta.

* 1876. G. Seguenza, Atti Accad. Pontaniana, vol. x, p. 386, pl. vii, figs. 1–13.